Stillaguamish Watershed – WRIA 5
Salmonid Habitat Evaluation

Version 1.02

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[1] Snohomish County and the Stillaguamish Tribe established the Stillaguamish Technical Advisory Group (TAG) in 1998 to provide scientific guidance on salmon recovery priorities for the Stillaguamish watershed, pursuant to the Washington State Salmon Recovery Act (RCW 77.85). The TAG was formed as a scientific subcommittee of the Stillaguamish Implementation Review Committee (SIRC) and authors independent scientific analyses.

INTRODUCTION AND OVERVIEW

This *Stillaguamish Watershed Salmonid Habitat Evaluation* identifies baseline multi-species salmonid habitat conditions in 22 subbasins based on existing scientific information.[2] This report was produced by the Stillaguamish Technical Advisory Group. It provides an application of publicly available scientific information and published research in the Stillaguamish River Basin to evaluate six habitat conditions in each subbasin.

The primary purpose of this work is to synthesize existing knowledge so that potential project sponsors may identify strategic near-term actions to protect and restore freshwater and estuarine salmonid habitat conditions. It is also intended as a reference for scientists and planners who may desire a concise resource for subbasin scale habitat condition identification. This evaluation may also be useful for communicating existing salmonid habitat conditions to public and private stakeholders, agencies, and elected officials.

This document synthesizes existing information and data on watershed and habitat conditions, with attention to subbasin scale geography. It is not a comprehensive plan or assessment and readers are strongly encouraged to refer to the research cited in this report and other available literature. This work builds on earlier salmonid habitat assessment work, including the *1999 Salmon Habitat Limiting Factors Report* (WCC, 1999) and the *Technical Assessment and Recommendations for Chinook Salmon Recovery in the Stillaguamish Watershed* (TAG, 2000), both of which provide more detailed descriptions of watershed habitat forming processes, land use factors and species distributions.

The approach used for this basin-wide salmonid habitat evaluation is a coarse screening method (see e.g. , Rhodes, et al., 1994) similar to that used in the neighboring Snohomish and Skagit River basins.[3] For this evaluation, the TAG examined the condition of the following six general habitat conditions for each of twenty-two subbasins: (1) habitat access, (2) floodplain and channel condition, (3) riparian function, (4) sediment regime, (5) hydrology and (6) water quality. Each habitat condition was evaluated by applying one or more condition criteria associated with the habitat limiting factors that are identified in the *Salmon Habitat Limiting Factors Report* (WCC, 1999). Limiting factors have spatial and temporal relationships that interact across these categories. Individual restoration projects will likely affect multiple conditions.

Seven habitat conditions are defined below including nearshore/estuary. This is followed by a presentation of the limiting factor criteria and relevant data sources, organized under the first six condition types.[4] Results are presented in a one page matrix organized by subbasin. A narrative description of the nearshore/estuary is provided. Literature are listed followed by an appendix which presents all data used to evaluate habitat conditions. A second appendix lists recommended habitat recovery actions, as found in the *Technical Assessment and Recommendations for Chinook Salmon Recovery in the Stillaguamish Watershed* (TAG,2000).

[2] The Stillaguamish Basin - WRIA 5 is currently divided into 3 watersheds totaling 22 subbasins. See page four. Previous scientific documents may refer to finer scale delineations in some areas of the WRIA.
[3] See the Skagit Watershed Council (1998 and 2000) and the Snohomish Basin Salmonid Recovery Technical Committee (2002).
[4] No criteria were applied to the Stillaguamish nearshore/estuary portion of the Lower Stillaguamish subbasin. A number of the high priority data gaps, as defined in TAG, 2000, exist in the nearshore/estuarine environment.

Habitat Condition Definitions

The following habitat condition descriptions were used to categorize habitat function in each subbasin of the Stillaguamish River. The six categories (and nearshore/estuarine) are not meant to be mutually exclusive but rather to represent key aspects of salmonid habitat.

The TAG used these habitat condition categories to designate subbasins as "suitable", "degraded" or "unsuitable".[5] Limiting factor condition criteria, scientific analyses and data, and GIS data were used to make these designations. Habitat condition determinations are derived from the application of the limiting factor criteria with existing publicly available data and published research. For some subbasins the same information and data were used to determine functionality in several categories. Data gaps are also shown.

Habitat Access

The ability of salmonids to access freshwater habitat for adult spawning and juvenile rearing is limited by artificial barriers including: dikes, levees, tide gates, hardened stream banks, culverts, channel fill, and fish screens. These hydromodifications may limit or block salmonid access to juvenile or adult habitat during all or part of the year and may restrict access to historical habitat.

Floodplain and Channel Condition

Physical channel and floodplain conditions can be degraded and simplified by human actions that modify the landscape directly through earth moving projects or indirectly by land uses that alter natural processes that shape the stream channels and floodplains. Such changes can result in reduced pool depth and frequency, loss of side channels and sloughs, restricted channel migration, and reduced floodplain connectivity. Each of these conditions reduces the amount and/or quality of salmonid habitat.

Riparian Function

Riparian trees and other vegetation are essential to the maintenance of suitable salmonid habitat. They contribute important structural and nutrient inputs, such as large wood and leaf litter, to the stream channel. They also provide shade and help stabilize stream banks. Loss of riparian function is directly related to the removal of riparian forest cover, removal of instream woody debris, and near-stream land use.

Sediment Regime

The amount, size, timing and delivery of sediments to the stream channel network affect the amount and quality of salmonid spawning and rearing habitats and specifically impact embryo survival and emergence success. Factors include: road building, agriculture, forest management, unstable geology, soils, impervious surfaces, unstable stream banks, and the magnitude and frequency of peak flows.

[5] See habitat condition criteria for specific definitions by limiting factor.

Hydrology

Changes to the delivery and routing of water can adversely affect salmonid habitat. Reduced baseflows can prevent access to habitat and diminish food production for salmonids. Increased magnitude, frequency and/or duration of peak flows can lead to decreased levels of in-channel large woody debris (LWD), decreased streambank stability, increased turbidity and other measures of sediment transport. These impacts are synergistic in the sense that transport/removal of LWD further decreases bank stability and further adds to the sediment transport load by removing instream roughness and reducing instream sediment storage. Loss of wetlands, forest and agricultural practices, and increased impervious area are key determinants of hydrologic function.

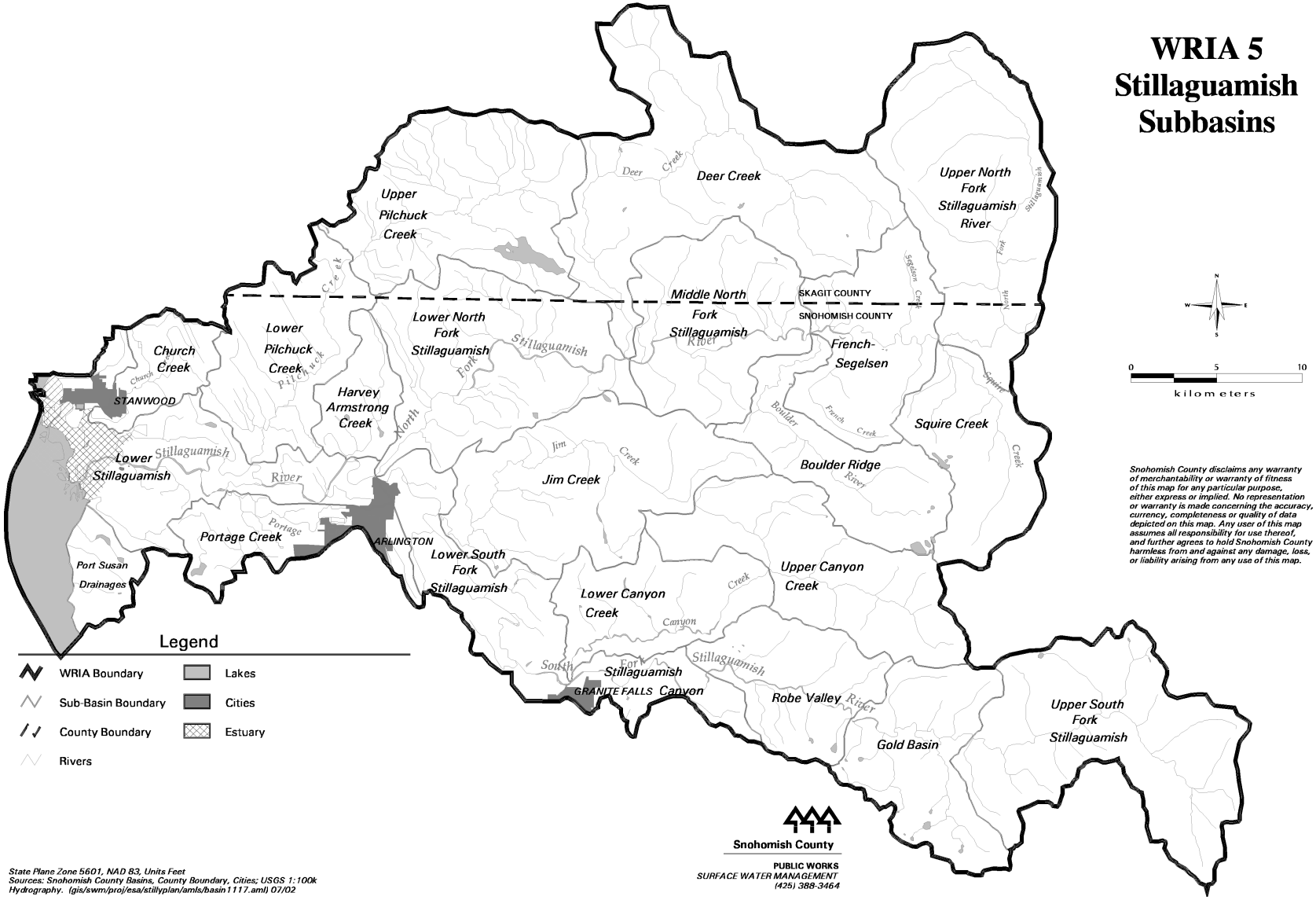
Water Quality

The chemical, physical and biological quality of water in freshwater and estuarine systems is easily degraded by pollutants and physical stream channel and riparian modifications. Toxic chemicals can have direct health effects on salmon and other aquatic organisms. Direct exposure of streamflows to solar radiation, due to lack of riparian vegetation, can increase water temperature to lethal levels for salmonids. Excessive inputs of nutrients and organic material can increase aquatic bacterial activity that consumes and reduces dissolved oxygen, needed by both juvenile and adult salmonids.

Nearshore and Estuarine Habitat

Tidelands, saltmarshes, mud flats, blind tidal channels, eelgrass beds and marine shoreline areas within the photic zone are examples of nearshore and estuarine habitat. Nearshore and estuarine areas have naturally high levels of biological productivity due to allochthonous nutrient inputs and habitat complexity. As a result, they are used by juvenile salmon for rearing and during the physiological transformation to the ocean-going life stage (smolt). Impacts to nearshore habitat include changes resulting from channelization, bank protection and land use in the estuarine zone. Limiting factors include loss of in-channel complexity, loss of historic salt marsh habitats and loss of access to rearing areas in side channel and sloughs.

MAP OF WRIA 5


WRIA 5
Stillaguamish
Subbasins
Upper Pilchuck Creek
Deer Creek
Upper North Fork Stillaguamish River
Middle North Fork Stillaguamish
SKAGIT COUNTY
SNOHOMISH COUNTY
Lower Pilchuck Creek
Lower North Fork Stillaguamish
French-Segelsen
Church Creek
STANWOOD
Harvey Armstrong Creek
Squire Creek
Lower Stillaguamish
Jim Creek
Boulder Ridge
Portage Creek
ARLINGTON
Lower South Fork Stillaguamish
Upper Canyon Creek
Lower Canyon Creek
Port Susan Drainages
GRANITE FALLS
Robe Valley
Gold Basin
Upper South Fork Stillaguamish
0 5 10
kilometers
Legend
WRIA Boundary
Sub-Basin Boundary
County Boundary
Rivers
Lakes
Cities
Estuary
Snohomish County disclaims any warranty of merchantability or warranty of fitness of this map for any particular purpose, either express or implied. No representation or warranty is made concerning the accuracy, currency, completeness or quality of data depicted on this map. Any user of this map assumes all responsibility for use thereof, and further agrees to hold Snohomish County harmless from and against any damage, loss, or liability arising from any use of this map.
State Plane Zone 5601, NAD 83, Units Feet
Sources: Snohomish County Basins, County Boundary, Cities; USGS 1:100k Hydrography. (gis/swm/proj/esa/stillyplan/amls/basin1117.aml) 07/02
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HABITAT CONDITION CRITERIA AND DATA SOURCES

Habitat Condition 1. Habitat Access

Limiting Factor: Loss of Access

% Habitat Accessible

Suitable	Degraded	Unsuitable
Human-made structures allow juvenile and adult fish passage to >90% of historical habitat at all flows	Human-made structures allow juvenile and adult fish passage to 80-90% of historical habitat at all flows	Human-made structures allow juvenile and adult fish passage to <80% of historical habitat at all flows

Source of criteria: Adapted by Stillaguamish TAG from NOAA (1996)[6]

Data sources:

- WDFW, 2001.
- Stillaguamish Tribe, 2001.
- SWM, 1995
- USFS, 2001
- DNR, 2001

Habitat Condition 2. Floodplain and Channel Condition

Limiting Factor: Woody Debris (WD)

Woody Debris(WD) - (greater than10 cm x 2m)

Suitable	Degraded	Unsuitable
>2 pieces WD/channel width[7]	1-2 pieces WD/channel width	<1 piece WD/channel width

Source of criteria: Bilby and Ward (1989).

Data sources:

- Beechie, 1992.
- DNR, 1996.
- Pess, et al. 1999.
- Pess, 1994-8.
- SWM, 2001.
- SWM, 2002.

[6] NOAA fish passage criteria evaluates fish passage at different flow conditions. Percentage criteria allows application of fish barrier passability data to determine upstream reach accessibility.

[7] WD/channel width is a measure of the number of pieces of woody debris at least 10 centimeters by 2 meters in a channel segment whose length is equal to the bankfull channel width. Bilby and Ward (1989) data from streams less than 20 m at bankfull width.

Limiting Factor: Pool Habitat

Pool Habitat

Suitable	Degraded	Unsuitable
Pool habitat is >50% of the low flow surface area	Pool habitat is 35-50% of the low flow surface area	Pool habitat is <35% of the low flow surface area

Source: WFPB (1992)

Data sources:

- Beechie, 1992.
- DNR, 1996.
- Pess, et al. 1999.
- Pess, 1994-8.
- SWM, 2001.
- SWM, 2002.

Limiting Factor: Bank Armoring

Bank Stability

Suitable	Degraded	Unsuitable
Shoreline hardening and unstable banks affect <10% of shorelines	Shoreline hardening and unstable banks affect 10-20% of shorelines	Shoreline hardening and unstable banks affect >20% of shorelines

Source of criteria: Adapted by Stillaguamish TAG from bank stability criteria in NOAA (1996).[8]

Data sources:

- DIS, 2002.
- SWM, 2001.
- SWM, 2002.

Habitat Condition 3. Riparian Function

Limiting Factor: Riparian Area

% Mature or mixed forest in riparian zone

Suitable	Degraded	Unsuitable
>80% of riparian zone within 300 feet of stream is composed of mature and mixed evergreen forest.[9]	65-80% of riparian zone within 300 feet is composed of mature and mixed evergreen forest.	<65% of riparian zone within 300 feet is composed of mature and mixed evergreen forest.

Source of criteria: Adapted from NOAA (1996).[10]

Data source:

- Purser & Simmonds, 2001.

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[8] NOAA criteria assesses "stable" stream banks. TAG criteria measures bank instability in the equivalent proportion.
[9] Land Cover Class 1 or 2 (Purser & Simmonds, 2001).
[10] Lower range is 70% intact riparian in NOAA, 1996.

Riparian forest condition

Suitable	Degraded	Unsuitable
<20% of riparian zone within 100 feet is fully degraded.[11]	20-35% of riparian zone within 100 feet of stream is fully degraded	>35% of riparian zone within 100 feet of stream is fully degraded

Source of criteria: Pollock (1998),

Data source:

- Pollock, 1998.

Habitat Condition 4. Sediment Regime

Limiting Factor: Sediment

Surface Fines

Suitable	Degraded	Unsuitable
<10% surface fines (<6.35 mm) in spawning areas	10-17% surface fines in spawning areas	>17% surface fines in spawning areas

Source of criteria: Bjornn and Reiser (1991).[12]

Data sources:

- Stillaguamish Tribe, 1980.
- SWM, 2001
- SWM, 2002

Riparian Buffer Filter

Suitable	Degraded	Unsuitable
>80% of riparian zone within 300 feet is composed of mature and mixed evergreen forest.[13]	65-80% of riparian zone within 300 feet is composed of mature and mixed evergreen forest.	<65% of riparian zone within 300 feet is composed of mature and mixed evergreen forest.

Source of criteria: Adapted from NOAA (1996).[14]

Data source:

- Purser & Simmonds. 2001.

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[11] Degraded forest: Predominantly small conifer or deciduous < 12" DBH; or medium deciduous 12"-20" DBH.
[12] Bjorn and Reiser present the result of basic research into the relation of embryo survival and % fine sediments (<6.35 mm) for cutthroat trout, rainbow trout, kokanee trout, steelhead trout, and chinook salmon. Cutthroat trout are the most sensitive of these species when it comes to fine sediment intrusion into redds. A fitted exponential (i.e., nonlinear) curve developed from numerous mean values and individual replicates shows that at 10% fine sediment, cutthroat trout embryo survival is reduced to about 80% (range 65-90%), while at 17% fine sediment embryo survival is approximately 55% (range 15-75%).
[13] Land Cover Class 1 and 2 (Purser and Simmonds, 2001).
[14] Lower range is 70% intact riparian in NOAA, 1996.

Habitat Condition 5. Hydrology

Limiting Factor: Loss of Wetlands

Loss of Wetlands

Suitable	Degraded	Unsuitable
>80% of historic wetland reserves intact.	50-80% of historic wetland reserves intact.	<50% of historic wetland reserves intact.

Source of criteria: NOAA (1996).

Data sources:[15]

- USFWS, 1999.
- NRCS, 1999

Limiting Factor: Peak Flow

Total Impervious Area

Suitable	Degraded	Unsuitable
Total Impervious Area is < 7 %	Total Impervious Area is 7-12 %	Total Impervious Area is > 12 %

Source of criteria: Spence, et al. (1996); May, et al. (1997)

Data sources:

- Purser & Simmonds. 2001.

Habitat Condition 6. Water Quality

Limiting Factor: Temperature/ Chemical Contamination/ Nutrients

Impaired Waterbodies

Suitable	Degraded	Unsuitable
No Clean Water Act (CWA) 303(d) designated reaches.[16]	One CWA 303(d) designated reach.	More than one CWA 303(d) designated reach.

Source of criteria: NOAA (1996).

Data sources:

- DOE, 2000.

[15] For additional data, see also: DOE (Washington State Department of Ecology). 1997. Characterization of Potential Wetland Restoration Sites within Washington State's Stillaguamish River Basin. Washington State Department of Ecology. Olympia, WA.

[16] A single impaired stream with multiple pollutants in the same reach was considered to have multiple 303(d) designated reaches.

STILLAGUAMISH HABITAT EVALUATION MATRIX

Habitat Condition	Habitat Access	Floodplain and Channel Condition	Floodplain and Channel Condition	Floodplain and Channel Condition	Riparian Function	Riparian Function	Sediment	Sediment	Hydrology	Hydrology	Hydrology	Water Quality
Limiting Factor	% Passable	Wood	Pools	Bank Stability	% Riparian Mature Forest	Riparian Forest Type	Surface Fines	Riparian Filter	Loss of Wetlands	Forest Cover	Total Impervious Area	303(d) List
Subbasin												
Boulder River	S	S	U	S	S	U	S	S	**	S	S	S
Church Creek	U	**	**	**	U	U	**	U	U	U	D	U
Deer Creek	S	U	U	**	D	S	**	D	**	S	S	U
French-Segelsen	S	D	U	D	U	U	S	U	**	D	S	S
Gold Basin	S	S	D	**	S	D	**	S	**	S	S	S
Harvey Armstrong Creek	S	**	**	U	U	U	**	U	U	U	S	U
Jim Creek	S	**	**	**	D	D	**	U	U	D	S	D
Lower Canyon Creek	S	D	U	S	U	S	D	U	U	D	S	S
Lower NF Stillaguamish	U	**	**	**	U	U	**	U	U	U	S	U
Lower Pilchuck Creek	U	**	**	**	U	U	**	U	U	U	S	U
Lower SF Stillaguamish	S	**	**	**	U	U	**	U	U	U	D	U
Lower Stillaguamish	S	**	**	U	U	U	**	U	U	U	U	U
Middle NF Stillaguamish	S	D	U	**	U	U	U	U	U	D	S	U
Port Susan Drainages	S	**	**	**	U	**	**	U	U	U	D	U
Portage Creek	U	**	**	**	U	U	**	U	U	U	D	U
Robe Valley	S	S	D	**	D	D	**	D	U	D	S	S
Squire Creek	S	D	D	S	U	U	S	U	**	D	D	D
Stillaguamish Canyon	S	D	S	S	D	S	U	D	U	D	S	U
Upper Canyon Creek	S	S	U	S	S	D	D	S	**	S	S	S
Upper NF Stillaguamish	S	D	U	**	D	D	**	D	**	S	S	S
Upper Pilchuck Creek	S	**	**	**	D	S	**	D	U	D	S	S
Upper SF Stillaguamish	S	S	U	**	D	U	**	D	**	S	S	S

Key: S – Suitable; D – Degraded; U – Unsuitable; ** – Data Gap.

*Habitat conditions based on application of criteria using published or publicly available data. Determinations made using available information as of June 2002 and summarized at the subbasin scale. Site or reach conditions may differ.

NEARSHORE AND ESTUARINE HABITAT

The role of marine nearshore and estuarine habitat in relation to the life histories and behavior of the different salmonid species that utilize the Stillaguamish watershed is not well understood. This is a significant data gap. In general it is known that marine nearshore and estuarine areas in Puget Sound provide refuge, feeding and migration areas for juvenile salmonids as well as food (e.g. forage fish) for adult salmonids. Nearshore tributary streams may also provide some degree of productive spawning habitat for sea-run cutthroat trout, chum salmon and coho salmon. Bull trout are also known to forage widely along nearshore areas and occasionally into nearshore tributaries. Specific locations of fish use and relative priorities of different nearshore and estuarine habitat types is not known (Williams & Thom, 2001).

The Stillaguamish Watershed, as defined by Water Resource Inventory Area 5 boundaries, includes 35.4 km of marine shoreline. While in better condition than urban nearshore areas in Puget Sound, Stillaguamish nearshore and estuarine habitat is constrained by hardened banks, sediment deposition and invasive species (WCC, 1999). Between 1870 and 1968 about 85% of the Stillaguamish tidal salt marsh was diked, drained and converted to agriculture with an associated loss in blind tidal channels. This habitat is essential to rearing of all juvenile salmonids. Accretion of sediment into Port Susan has resulted in greater than 4 km^2 of mud/sand flats without the benefits of salt march or tidal channel. Invasive species (e.g. Spartina) are prevalent and threaten to eliminate native marsh vegetation and raise the elevation of the estuary substrate (Collins, 1997)

Estimates of Historic and Current Salt Marsh Habitat Reclaimed by Dikes on the Stillaguamish River Delta and Newly Reclaimed Areas (Collins, 1997)

Site	**1870 (Pre Settlement)**	**1886**	**1968 Original**	**1968 New**
	-- Salt Marsh (hectares) --			
South of Hatt Slough	197	38	0	40
Stillaguamish Delta	423	69	40	156
Leque's Island	192	87	34	89
East of Douglas Slough	523	85	46	0
West of Douglas Slough	272	201	150	0
Camano Island	189	118	0	64
Total	**1796**	**598**	**270**	**349**

Degradation of nearshore and estuarine habitats from past land use is clear. However, more research and data are needed to determine the condition and salmonid use of the Stillaguamish marine environment and its current and future suitability for salmon.

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APPENDIX A – SUBBASIN HABITAT DATA

% Fish Passability

Subbasin	Total kilometers of Fish-Passage*	Total km of DNR Type 1,2,3	Percent Passable	Condition
Boulder River	28.06	28.06	100.0%	Suitable
Church Creek	1.17	23.20	5.0%	Unsuitable
Deer Creek	79.33	80.13	99.0%	Suitable
French-Segelsen	41.28	45.33	91.1%	Suitable
Gold Basin	50.62	50.62	100.0%	Suitable
Harvey Armstrong Creek	14.91	16.19	92.0%	Suitable
Jim Creek	72.78	74.74	97.4%	Suitable
Lower Canyon Creek	49.42	49.42	100.0%	Suitable
Lower North Fk Stillaguamish	77.76	98.53	78.9%	Unsuitable
Lower Pilchuck Creek	41.42	54.46	76.0%	Unsuitable
Lower South Fk Stillaguamish	50.30	50.69	99.3%	Suitable
Lower Stillaguamish	64.46	69.23	93.1%	Suitable
Middle North Fk Stillaguamish	63.07	64.61	97.6%	Suitable
Port Susan Drainages	5.07	5.07	100.0%	Suitable
Portage Creek	29.07	46.26	62.8%	Unsuitable
Robe Valley	38.11	40.18	94.9%	Suitable
Squire Creek	41.84	41.89	99.9%	Suitable
Stillaguamish Canyon	16.93	16.93	100.0%	Suitable
Upper Canyon Creek	36.29	36.88	98.4%	Suitable
Upper North Fk Stillaguamish	55.76	56.72	98.3%	Suitable
Upper Pilchuck Creek	48.83	50.19	97.3%	Suitable
Upper South Fk Stillaguamish	62.86	64.14	98.0%	Suitable

* Calculated for all DNR type 1,2,3 streams and considering all instream modifications with less than 100% fish passability. “Fish-passage” stream kilometer totals show a cumulative measurement of the stream segment kilometers in the subbasin upstream of blocking instream modifications, proportional to fish passability at downstream structures.

Pieces Woody Debris/Channel Width

Subbasin	Surveyed (km)	Data Source	WD/cw	WD Condition
Boulder River	4.01	SWM, 2001	2.15	Suitable
Church Creek				Data Gap
Deer Creek	9.76	Beechie, 1992	0.59	Unsuitable
French-Segelsen	10.73	Pess et al., 1999 (3.47 km); SWM, 2001 (7.26 km)	1.33	Degraded
Gold Basin	6.27	Pess et al.,1999 and Pess, 1994-98	3.76	Suitable
Harvey Armstrong Creek				Data Gap
Jim Creek				Data Gap
Lower Canyon Creek	12.75	Pess et al., 1999 (1.45 km) and SWM, 2001 (11.3 km)	1.03	Degraded
Lower North Fork Stillaguamish				Data Gap
Lower Pilchuck Creek				Data Gap
Lower South Fork Stillaguamish				Data Gap
Lower Stillaguamish				Data Gap
Middle North Fork Stillaguamish	9.14	Pess et al., 1999 (3.51 km) and SWM, 2001 (5.63 km)	1.23	Degraded
Port Susan Drainages				Data Gap
Portage Creek				Data Gap
Robe Valley	7.84	Pess, et al., 1999 and Pess, 1994-98	2.2	Suitable
Squire Creek	10.65	Pess et al., 1999 (4.22 km) and SWM, 2001 (6.43 km) data	1.75	Degraded
Stillaguamish Canyon	1.64	SWM, 2002	1.34	Degraded
Upper Canyon Creek	6.8	Pess, et al., 1999 (0.48 km) and SWM, 2001 (6.32 km)	2.16	Suitable
Upper North Fork Stillaguamish	10.37	Pess, et al., 1999	1.88	Degraded
Upper Pilchuck Creek				Data Gap
Upper South Fork Stillaguamish	12.84	Pess, et al., 1999	3.86	Suitable
Pess et al., 1999 WD data used criteria of 10 cm diameter and 1 m length; SWM, 2001 counted no wood less than 30 cm diameter and 7.6 m length; SWM, 2002 tallied small wood which measured at least 10 cm diameter and 2 m in length.				
Data gaps result from less than 10% of fish bearing waters surveyed in subbasin or no data.				

% Pool Habitat as Percentage of Low Flow Surface Area

Subbasin	Surveyed (km)	Data Sources	Pool Area %	Pool Condition
Boulder River	4.01	SWM, 2001	18.82	Unsuitable
Church Creek				Data Gap
Deer Creek	9.76	Beechie, 1992	20.05	Unsuitable
French-Segelsen	10.73	Pess et al., 1999 (3.47 km); SWM, 2001 (7.26 km)	15.42	Unsuitable
Gold Basin	6.27	Pess, et al., 1999 and Pess, 1994-98	37	Degraded
Harvey Armstrong Creek				Data Gap
Jim Creek				Data Gap
Lower Canyon Creek	12.75	Pess et al., 1999 (1.45 km) and SWM, 2001 (11.3 km)	22.18	Unsuitable
Lower North Fork Stillaguamish				Data Gap
Lower Pilchuck Creek				Data Gap
Lower South Fork Stillaguamish				Data Gap
Lower Stillaguamish				Data Gap
Middle North Fork Stillaguamish	9.14	Pess et al., 1999 (3.51 km) and SWM, 2001 (5.63 km)	20.45	Unsuitable
Port Susan Drainages				Data Gap
Portage Creek				Data Gap
Robe Valley	7.84	Pess, et al., 1999 and Pess, 1994-98	39.58	Degraded
Squire Creek	10.65	Pess et al., 1999 (4.22 km) and SWM, 2001 (6.43 km) data	36.89	Degraded
Stillaguamish Canyon	1.64	SWM, 2002	74.63	Suitable
Upper Canyon Creek	6.8	Pess, et al., 1999 (0.48 km) and SWM, 2001 (6.32 km)	16.71	Unsuitable
Upper North Fork Stillaguamish	10.37	Pess, et al., 1999	27.77	Unsuitable
Upper Pilchuck Creek				Data Gap
Upper South Fork Stillaguamish	12.84	Pess, et al., 1999	26.5	Unsuitable
Data gaps result from less than 10% of fish bearing waters surveyed in subbasin or no data.				

Shoreline Hardening or Unstable Banks as % of Shorelines

Subbasin	Surveyed (km)	Bank Stability Source	Bank Stability %	Percent dikes or hardened banks.	Unstable + hardened	Bank Stability Condition
Boulder River	4.01	SWM, 2001	8.53	0.00	8.53	Suitable
Church Creek						Data Gap
Deer Creek						Data Gap
French-Segelsen	7.26	SWM, 2001	10.57	0.04	10.61	Degraded
Gold Basin						Data Gap
Harvey Armstrong Creek				18.3	(> 20)*	Unsuitable
Jim Creek						Data Gap
Lower Canyon Creek	11.3	SWM, 2001	7.74	0.25	7.99	Suitable
Lower North Fork Stillaguamish						Data Gap
Lower Pilchuck Creek						Data Gap
Lower South Fork Stillaguamish						Data Gap
Lower Stillaguamish				21.17	(> 20)*	Unsuitable
Middle North Fork Stillaguamish						Data Gap
Port Susan Drainages						Data Gap
Portage Creek						Data Gap
Robe Valley						Data Gap
Squire Creek	6.43	SWM, 2001	7.77	0	7.77	Suitable
Stillaguamish Canyon	1.64	SWM, 2002	6.96	0	6.96	Suitable
Upper Canyon Creek	6.32	SWM, 2001	7.13	0	7.13	Suitable
Upper North Fork Stillaguamish						Data Gap
Upper Pilchuck Creek						Data Gap
Upper South Fork Stillaguamish						Data Gap
Hardened Bank and Dikes Data Source: DIS, 1997						
Data Gaps result from Less than 10% of fish bearing waters surveyed in subbasin or no data.						
*Note: Lower Stillaguamish and Harvey Armstrong unsuitability assumes greater than 2% unstable banks.						

% Forest within 300' of Streams and Waterbodies

Subbasin	Mature Evergreen Forest	Mixed Forest	Unknown	Adjuster	Adjusted Total Forest	Condition
Boulder River	25	48	10	1.11	81	Suitable
Church Creek	0	24	1	1.01	24	Unsuitable
Deer Creek	16	61	2	1.02	79	Degraded
French-Segelsen	11	50	3	1.03	63	Unsuitable
Gold Basin	30	49	6	1.06	84	Suitable
Harvey Armstrong Creek	0	38	1	1.01	38	Unsuitable
Jim Creek	10	54	1	1.01	65	Unsuitable
Lower Canyon Creek	8	50	2	1.02	59	Unsuitable
Lower North Fork Stillaguamish	3	48	1	1.01	52	Unsuitable
Lower Pilchuck Creek	0	39	0	1.00	39	Unsuitable
Lower South Fork Stillaguamish	1	34	1	1.01	35	Unsuitable
Lower Stillaguamish	0	15	0	1.00	15	Unsuitable
Middle North Fork Stillaguamish	7	53	1	1.01	61	Unsuitable
Port Susan Drainages	0	33	1	1.01	33	Unsuitable
Portage Creek	0	21	0	1.00	21	Unsuitable
Robe Valley	15	52	3	1.03	69	Degraded
Squire Creek	19	34	9	1.10	58	Unsuitable
Stillaguamish Canyon	6	60	2	1.02	67	Degraded
Upper Canyon Creek	24	53	7	1.08	83	Suitable
Upper North Fork Stillaguamish	20	59	1	1.01	80	Degraded
Upper Pilchuck Creek	8	60	1	1.01	69	Degraded
Upper South Fork Stillaguamish	23	44	9	1.10	74	Degraded
Data Sources: Purser & Simmonds, 2001; DIS, 2002.						

Forest Cover Type in Riparian Zone (100' buffer)

Subbasin	Intact or Recovering	Degraded but Recovering	Degraded	Condition
Boulder River	64.2%	0.7%	35.1%	Unsuitable
Church Creek	0.7%	7.5%	91.8%	Unsuitable
Deer Creek	43.8%	38.9%	17.3%	Suitable
French-Segelsen	50.8%	11.6%	37.6%	Unsuitable
Gold Basin	66.0%	12.5%	21.5%	Degraded
Harvey Armstrong Creek	18.3%	9.5%	72.2%	Unsuitable
Jim Creek	24.3%	51.9%	23.8%	Degraded
Lower Canyon Creek	67.1%	28.3%	4.6%	Suitable
Lower North Fk Stillaguamish	50.3%	13.4%	36.3%	Unsuitable
Lower Pilchuck Creek	36.1%	22.6%	41.3%	Unsuitable
Lower South Fk Stillaguamish	50.3%	9.2%	40.5%	Unsuitable
Lower Stillaguamish	2.3%	3.3%	94.4%	Unsuitable
Middle North Fk Stillaguamish	35.3%	25.0%	39.6%	Unsuitable
Port Susan Drainages				Data Gap
Portage Creek	9.5%	0.0%	90.5%	Unsuitable
Robe Valley	61.6%	9.1%	29.3%	Degraded
Squire Creek	49.2%	2.6%	48.2%	Unsuitable
Stillaguamish Canyon	29.6%	58.6%	11.8%	Suitable
Upper Canyon Creek	53.9%	23.2%	22.9%	Degraded
Upper North Fk Stillaguamish	53.4%	22.9%	23.7%	Degraded
Upper Pilchuck Creek	57.8%	38.4%	3.9%	Suitable
Upper South Fk Stillaguamish	54.0%	8.4%	37.6%	Unsuitable

Definitions

Intact or Recovering	cld,cls,cmd,cms,mmd,mms
Degraded but Recovering	csd,msd
Degraded	css,cys,mss,dss,dms,dmd,dsd,s

Attribute Codes

1st letter: c=conifer, m=mixed, d=deciduous
2nd letter: l=large, m=mature/medium, s=small, y=young
3rd letter: d=dense, s=sparse
A single s=shrub

Data Source: Pollock, Michael. 1998. (1992 Aerial Photo Series Analysis)
Data Gap: Not Surveyed

% Surface Fines < 6.35 mm

Subbasin	Surveyed (km)	Data Sources	Surface Fines (<6.35mm) %	Surface Fines Condition
Boulder River	4.01	SWM, 2001	5.32	Suitable
Church Creek				Data Gap
Deer Creek				Data Gap
French-Segelsen	7.26	SWM, 2001	11.15	Degraded
Gold Basin				Data Gap
Harvey Armstrong Creek				Data Gap
Jim Creek				Data Gap
Lower Canyon Creek	11.3	SWM, 2001	14.44	Degraded
Lower North Fork Stillaguamish				Data Gap
Lower Pilchuck Creek				Data Gap
Lower South Fork Stillaguamish				Data Gap
Lower Stillaguamish				Data Gap
Middle North Fork Stillaguamish	5.63	SWM, 2001	29.11	Unsuitable
Port Susan Drainages				Data Gap
Portage Creek				Data Gap
Robe Valley				Data Gap
Squire Creek	6.43	SWM, 2001	6	Suitable
Stillaguamish Canyon	1.64	SWM, 2002	56.58	Unsuitable
Upper Canyon Creek	6.32	SWM, 2001	5.42	Suitable
Upper North Fork Stillaguamish				Data Gap
Upper Pilchuck Creek				Data Gap
Upper South Fork Stillaguamish				Data Gap
Data gaps result from less than 10% of fish bearing waters surveyed in subbasin or no data.				

Potential Loss of Wetlands by Subbasin

Subbasin	Current Acres (NWI)*	Historic Acres (SSURGO hydric soils)^	% Wetland Intact	Condition
Boulder River				Data Gap
Church Creek	370.06	2138.71	17%	Unsuitable
Deer Creek				Data Gap
French-Segelsen				Data Gap
Gold Basin				Data Gap
Harvey Armstrong Creek	394.25	1074.20	37%	Unsuitable
Jim Creek	254.55	1271.13	20%	Unsuitable
Lower Canyon Creek	148.01	365.56	40%	Unsuitable
Lower North Fork Stillaguamish	865.91	2915.22	30%	Unsuitable
Lower Pilchuck Creek	548.65	1784.92	31%	Unsuitable
Lower South Fork Stillaguamish	602.83	1512.31	40%	Unsuitable
Lower Stillaguamish	1154.19	9667.64	12%	Unsuitable
Middle North Fork Stillaguamish	135.44	1018.10	13%	Unsuitable
Port Susan Drainages	62.81	168.17	37%	Unsuitable
Portage Creek	736.52	3226.08	23%	Unsuitable
Robe Valley	242.88	674.36	36%	Unsuitable
Squire Creek				Data Gap
Stillaguamish Canyon	29.25	204.88	14%	Unsuitable
Upper Canyon Creek				Data Gap
Upper North Fork Stillaguamish				Data Gap
Upper Pilchuck Creek	413.07	980.90	42%	Unsuitable
Upper South Fork Stillaguamish				Data Gap
GIS Data Sources: Subbasins - DIS, 2002; * National Wetlands Inventory (NWI) - USFWS, 1999; ^ Soils Survey Geographic (SSURGO) - NRCS, 1999.				
Data Gap - Geographic Extent of Data Incomplete.				

% Forest by Subbasin

Subbasin	Mature Evergreen Forest	Mixed Forest	Unknown	Adjusted Total Forest	Condition
Boulder River	21	48	10	77	Suitable
Church Creek	0	20	1	20	Unsuitable
Deer Creek	15	62	2	79	Suitable
French-Segelsen	13	50	2	64	Degraded
Gold Basin	26	55	4	84	Suitable
Harvey Armstrong Creek	0	36	2	37	Unsuitable
Jim Creek	8	53	1	62	Degraded
Lower Canyon Creek	6	48	1	55	Degraded
Lower North Fork Stillaguamish	2	44	1	46	Unsuitable
Lower Pilchuck Creek	0	39	1	39	Unsuitable
Lower South Fork Stillaguamish	1	33	1	34	Unsuitable
Lower Stillaguamish	0	15	0	15	Unsuitable
Middle North Fork Stillaguamish	7	50	1	58	Degraded
Port Susan Drainages	0	34	1	34	Unsuitable
Portage Creek	0	20	0	20	Unsuitable
Robe Valley	13	52	3	67	Degraded
Squire Creek	20	32	8	57	Degraded
Stillaguamish Canyon	4	60	1	65	Degraded
Upper Canyon Creek	22	56	5	82	Suitable
Upper North Fork Stillaguamish	16	59	1	76	Suitable
Upper Pilchuck Creek	5	58	1	64	Degraded
Upper South Fork Stillaguamish	21	45	9	73	Suitable
Data Source: Purser & Simmonds, 2001					

% Total Impervious Area (TIA) by Subbasin

Subbasin	High Impervious	Medium Impervious	Open Water	Unknown Areas	Adjusted TIA	Condition
Boulder River	3	3	1	10	6	Suitable
Church Creek	5	11	0	1	10	Degraded
Deer Creek	1	2	0	2	2	Suitable
French-Segelsen	0	2	0	2	1	Suitable
Gold Basin	0	1	0	4	0	Suitable
Harvey Armstrong Creek	2	7	0	2	5	Suitable
Jim Creek	1	3	0	1	2	Suitable
Lower Canyon Creek	1	5	0	1	3	Suitable
Lower North Fork Stillaguamish	1	4	0	1	3	Suitable
Lower Pilchuck Creek	1	5	0	1	3	Suitable
Lower South Fork Stillaguamish	3	9	1	1	8	Degraded
Lower Stillaguamish	6	10	2	0	13	Unsuitable
Middle North Fork Stillaguamish	1	2	0	1	2	Suitable
Port Susan Drainages	3	12	1	1	10	Degraded
Portage Creek	5	13	1	0	12	Degraded
Robe Valley	1	2	0	3	2	Suitable
Squire Creek	4	7	1	8	9	Degraded
Stillaguamish Canyon	2	4	0	1	4	Suitable
Upper Canyon Creek	1	2	0	5	2	Suitable
Upper North Fork Stillaguamish	0	1	0	1	0	Suitable
Upper Pilchuck Creek	0	2	2	1	3	Suitable
Upper South Fork Stillaguamish	2	3	0	9	3	Suitable
Adjusted TIA: High impervious + 50% of medium impervious + open water, as % of known area.						
Data Source: Purser & Simmonds, 2001						

Clean Water Act 303(d) Designated Reaches (1998 List)

Subbasin	Temperature	Other contaminants*	Condition
Boulder River			Suitable
Church Creek		4 x Fecal	Unsuitable
Deer Creek	3 reaches		Unsuitable
French-Segelsen			Suitable
Gold Basin			Suitable
Harvey Armstong Creek		3 x Fecal	Unsuitable
Jim Creek		1 x Fecal	Degraded
Lower Canyon Creek			Suitable
Lower North Fork Stillaguamish	1 reach	1 x Fecal	Unsuitable
Lower Pilchuck Creek	1 reach	1 x DO	Unsuitable
Lower South Fork Stillaguamish	1 reach	1 x Fecal + pH	Unsuitable
Lower Stillaguamish	4 reaches	1 x Ammonia + 2 x DO + 4 x Fecal + 4 x Metal	Unsuitable
Middle North Fork Stillaguamish		2 x Fecal	Unsuitable
Port Susan Drainages		2 x Fecal	Unsuitable
Portage Creek		6 x DO + 10 x Fecal + 2 x Turbidity	Unsuitable
Robe Valley			Suitable
Squire Creek			Suitable
Stillaguamish Canyon	1 reach	1 x DO + 2 x Fecal	Unsuitable
Upper Canyon Creek			Suitable
Upper North Fork Stillaguamish			Suitable
Upper Pilchuck Creek			Suitable
Upper South Fork Stillaguamish			Suitable
Sunday Lake		2 x Nutrients	Unsuitable
(DO = Dissolved Oxygen)			
GIS Data Sources: 1) DOE, 2000; DIS, 2002.			
* Fecal coliform indicates the presence of pathogens but may not necessarily indicate degraded salmon habitat. Fecals may be associated with increased nutrient levels and low DO which do have direct impacts.			

APPENDIX B – RECOVERY ACTIONS

The following recovery actions were identified by the Stillaguamish Technical Advisory Group in 2000 and are detailed in the *Technical Assessment and Recommendations for Chinook Salmon Recovery in the Stillaguamish Watershed* (TAG, 2000). This document also serves as the Stillaguamish Lead Entity Strategy. This strategy specifically addresses chinook salmon (*Oncorhynchus tshawytscha*) and was developed to address ecosystem-wide limiting factors as a foundation for multi-species salmon recovery. Please refer to the original document for detailed descriptions and background.

a) Loss and degradation of riparian/shoreline/floodplain vegetation and LWD recruitment – actions that focus on enhancing riparian areas, promoting retention of mature forest characteristics and restoring hydrologic connectivity.

b) Loss and degradation of in-channel and off-channel rearing habitat – actions that focus on maintaining mature forest cover, maintaining low impervious surfaces and allowing channel migration.

c) Loss and degradation of estuary and near shore habitat – actions that focus on the restoration and enhancement of lost or degraded estuarine habitat areas and conditions preferred by chinook juveniles.

d) Loss and degradation of spawning habitat – actions that focus on the restoration of natural hydrologic and sediment regimes, wood recruitment and channel migration.

e) Loss of large and deep holding pools for adult chinook – actions that focus on improving capacity of riparian areas to contribute LWD.

f) Degradation of Water Quality – action that focus on decreasing sediment, increasing hydrologic connectivity and enhancing riparian areas and wetlands.

These recovery actions should be guided by the data and analysis presented in the *Stillaguamish Watershed – WRIA 5 Salmonid Habitat Evaluation Version 1.02*, original source documents and reach scale field data gathering during project feasibility analysis. Identified actions may correspond to one or more habitat conditions.